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MUSIC

Head and neck injury risks in heavy metal: head bangers stuck between rock and a hard bass

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Accepted: 6 November 2008

Cite this as: *BMJ* 2008;337:a2825

Abstract

Objective To investigate the risks of mild traumatic brain injury and neck injury associated with head banging, a popular dance form accompanying heavy metal music.

Design Observational studies, focus group, and biomechanical analysis.

Participants Head bangers.

Main outcome measures The Head Injury Criterion and Neck Injury Criterion were derived for head banging styles and both popular heavy metal songs and easy listening music controls.

Results An average head banging song has a tempo of about 146 beats per minute, which is predicted to cause mild head injury when the range of motion is greater than 75°. At higher tempos and greater ranges of motion there is a risk of neck injury.

Conclusion To minimise the risk of head and neck injury, head bangers should decrease their range of head and neck motion, head bang to slower tempo songs by replacing heavy metal with adult oriented rock, only head bang to every second beat, or use personal protective equipment.

Introduction

Young people at heavy metal concerts often report being dazed and confused, possible symptoms of mild traumatic brain injury. Little formal research has been conducted on the worldwide phenomenon of head banging, even though case reports indicate the inher-

ent risks in this activity, especially in head and neck injury. Head banging is a violent activity associated with hard rock and various subgenres of heavy metal. Though exposure to head banging is enormous, opportunities are present to control this risk—for example, encouraging bands such as AC/DC to play songs like “Moon River” as a substitute for “Highway to Hell”; public awareness campaigns with influential and youth focused musicians, such as Sir Cliff Richard; labelling of music packaging with anti-head banging warnings, like the strategies used with cigarettes; training; and personal protective equipment.

The head banging story begins in 1968 when Led Zeppelin were playing a set at the Boston Tea Party on their first US tour. The front rows of the audience were banging their heads against the stage in time to the music and the term “head banger” was born.^{6 7} It now refers to violent and rhythmic movement of the head synchronous with music, most commonly heavy metal music.⁸ It has etched its mark in popular culture with the likes of Beavis and Butt-head and Wayne, Garth, and friends in the movie *Wayne’s World*.

There are many different styles of head banging such as the up-down, the circular swing, the full body, or the side-to-side. Jason Newsted, known for his circular swinging style head banging, gave “physical damage” as one of the reasons for his departure from the band Metallica in 2001.¹² In 2005, doctors believed that Terry



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Top 11 head banging songs as chosen by focus group of 10 musicians

Band	Song	Tempo*
Queen	Bohemian Rhapsody	138
Deep Purple	Smoke on the Water	114
Black Sabbath	Paranoid	164
Led Zeppelin	Communication Breakdown	175
Guns N’ Roses	Paradise City	100
AC/DC	Whole Lotta Rosie	160
Mötley Crüe	Kickstart My Heart	179
Motörhead	Ace of Spades	141
Van Halen	Hot for Teacher	128
Quiet Riot	Bang Your Head (Mental Health)	121
Spinal Tap	Tonight I’m Gonna Rock You Tonight	182

*Beats per minute.

Balsamo, the guitarist from the band Evanescence, experienced a stroke from head banging.¹³ Head banging caused a traumatic aneurysm of the cervical vertebral artery in a 15 year old drummer,¹⁴ and one case of subdural haematoma was reported to be caused by the shearing strain induced by the head and neck motion exhibited during head banging.⁸ We investigated the injury risk arising from head banging using biomechanical methods and the possible methods for controlling those risks.

Methods

We conducted an observational study to identify the most popular head banging technique. We attended several hard rock and heavy metal concerts to find the most common style of head banging executed by audience members. The bands performing at these concerts included Motörhead, Mötley Crüe, Skid Row, The Hell City Glamours, L.A. Guns, Ozzy Osbourne, Winger, Ratt, Whitesnake, and W.A.S.P. It was evident that most people engaging in head banging chose to perform the up-down style.

Using the results of the observational study, we undertook biomechanical analyses. Previous studies have shown that angular head velocity, and therefore also angular displacement and acceleration, during head oscillation in pitch are approximately sinusoidal.¹⁵ Therefore we constructed a theoretical head banging model with the basic assumption that the angular displacement of the head during head oscillation in pitch follows a sinusoidal motion in the sagittal plane with the T1-C7 joint acting as the axis of rotation. We used reported coordinates of the centre of gravity of the head and the T1-C7 joint for a 50th centile adult male and calculated the radius of rotation of the head to be about 174.0 mm.

The amplitude of the displacement curve was based on the range of motion of the cervical spine of an adult male—60.4° flexion and 69.9° extension,—giving a total of 130.3°. Therefore we varied the range of motion from 45° to 120° by increments of 15° to investigate the effect that the range of motion has on injury severity.

We varied the range of angular displacement of the head and neck and the frequency of the movement in the theoretical model and calculated Head Injury

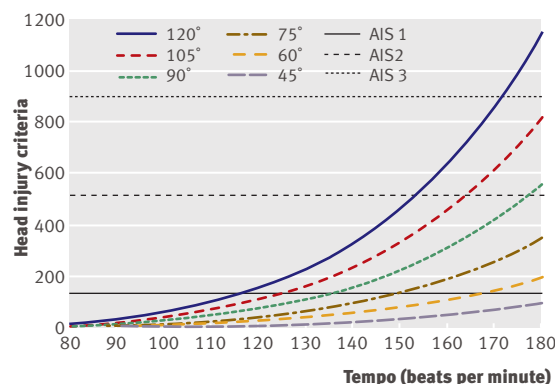


Fig 1 | Head banging tempo v the head injury criterion (HIC) for various head and neck ranges of motion (45° to 120°). Abbreviated injury scale (AIS) thresholds indicated as horizontal lines

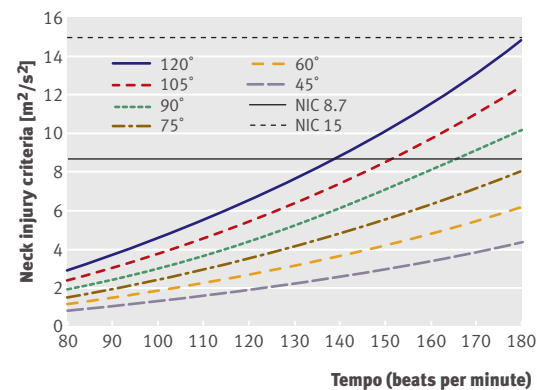


Fig 2 | Head banging tempo v neck injury criterion (NIC) for various head and neck ranges of motion (45° to 120°). Abbreviated injury scale thresholds indicated as horizontal lines

Criterion (HIC) and Neck Injury Criterion (NIC) levels. See bmj.com for details of the theoretical models used.

We asked a focus group of 10 musicians from local bands to nominate their favourite head banging song. Musical training or talent was not a prerequisite for membership of this group. We compiled an ordered list of the top 11 songs. As each song was played, members of the focus group were asked to tap out the beat of the song for the duration of one minute, so we could calculate the average tempo of each song.

We randomly selected three songs (“I Will Always Love You” by Whitney Houston, “Hello” by Lionel Richie, and “Babe” by Styx) from online lists of easy listening and adult oriented rock as musical controls.

Results

If the head and neck range of motion exceeds 45° there are definite risks of mild traumatic brain injury related to the range of motion and tempo (fig 1). There is an increasing risk of neck injury starting at tempos of 130 beats per minute related to the range of motion in the head banging style (fig 2).

Discussion

The top 11 head banging songs chosen by the focus group were all performed by hard rock or heavy metal artists, even though there was no restriction placed on genre. These songs had an average tempo of 146 beats per minute, and at this tempo we predict that head banging can cause headaches and dizziness (dazed and confused) if the range of movement of the head and neck is greater than 75°. Head banging at 146 beats per minute with 105° range of motion can cause NIC to exceed 8 m²/s², which is the lowest injury threshold. Therefore, predicted risks for acute neck injury with moderate tempo heavy metal and restricted neck motion in our model are limited.

Many hard rock and heavy metal bands play fast tempo songs, such as Spinal Tap’s “Tonight I’m Gonna Rock You Tonight” and “Kickstart My Heart” by glam metal band Mötley Crüe, both with tempos around 180 beats per minute. If someone were to head bang at this tempo with 120° range of motion, the neck injury criterion (fig 2) is in the vicinity of the long term injury

WHAT IS ALREADY KNOWN ON THIS TOPIC

Case reports indicate that head banging might cause brain and neck injury

Head banging to heavy metal is a popular dance form

WHAT THIS STUDY ADDS

The application of biomechanical methods identified a definite risk of mild traumatic brain injury from head banging

The study helps to explain why metal concert goers often seem dazed, confused, and incoherent

threshold of $15 \text{ m}^2/\text{s}^2$. For the same tempo and range of movement the head injury criterion (fig 1) predicted that the activity will result in abbreviated injury scale level 3 injuries, and that the range of motion of the head must be below 45° for level 1 injuries to be avoided. It is at this point that the question of whether someone can render themselves unconscious while head banging needs to be asked. It would be more likely for this to occur if someone was banging their head on the stage while in the first row of a Led Zeppelin concert or if

they were coming in contact with the head of another audience member. The physical limitations of the neck muscles make it difficult for the head to travel through a large range of movement while head banging to songs of such a high speed.

Possible interventions to reduce the risk of injury caused by head banging include limiting the range of neck motion through a formal training programme delivered before a concert; substitution of adult oriented rock and easy listening music such as the controls, or others including Michael Bolton, Celine Dion, Enya, and Richard Clayderman, for heavy metal; and personal protective equipment such as neck braces to limit range of motion. Future research will involve neuropsychological testing of concert goers to validate the modelling presented in this paper, and randomised controlled trials of musical substitutes.

Contributors: See bmj.com.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests: None declared.

Ethical approval: Not required.

Provenance and peer review: Not commissioned; externally peer reviewed.

References are on bmj.com.

Texting shows recovery after faint

Festival Medical Services is a charitable trust that provides music festivals throughout the United Kingdom with doctors, nurses, paramedics, first aiders, and other trained medical and administrative staff. One of the authors (MS) is the coordinator for the Festival Medical Services "pit crew." This team provides a resuscitation facility for the audience at the two main stages at Glastonbury and Reading festivals as well as a triage system to sort or treat people who need medical attention. The team follows the advice of the Third Annual Rock Concert Safety Survey Report published by Crowd Management Strategies in February 1995 (www.crowdsafe.com/mosh.html).

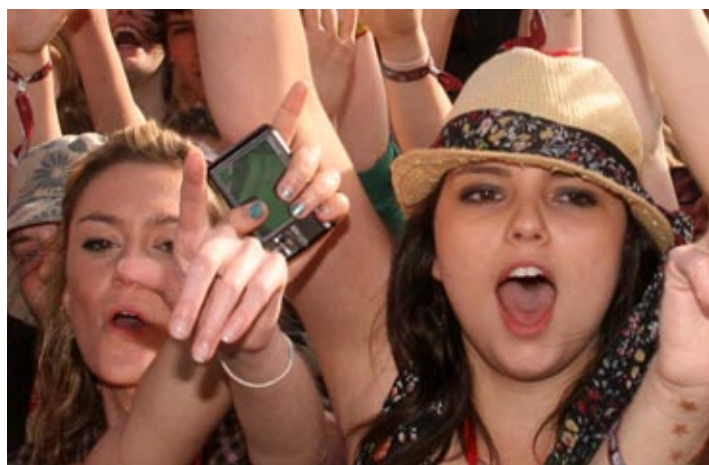
Festival Medical Services has a small tent (3 m × 3 m) at the side of these stages, with resuscitation equipment as suggested by the Resuscitation Council UK's recommended minimum equipment for in-hospital adult resuscitation.¹ A consultant anaesthetist, two nurses, an operating department practitioner, and at least two first aiders are present from when the first band appears on stage until the last

band of the day finishes.

Three years ago we noticed that most of the patients with faint or panic attack were teenagers and as soon as they could they used their mobile phones to send an SMS (short message service) text message to their friends. SMS allows the interchange of short text messages between mobile phones. About 1.4 billion text messages are sent in the UK alone every week, according to the Mobile Data Association (www.text.it).

The ability to text, whether or not it actually makes sense, requires a Glasgow coma scale score of 15 (fully conscious), an adequately functioning "executive system" in the frontal lobes, and a high degree of manual dexterity and psychomotor coordination. It also shows a degree of common sense not always evident in teenagers.

Two years ago we decided to use this texting sign as an indication that patients had recovered from their faint or panic attack and were orientated and coordinated enough to be discharged back to the festival. At times of massive influx to the medical tent, when up to two patients



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a minute are triaged, this system seems to work well.

This year at the Reading festival we treated 142 patients in less than 60 minutes during the performance by Bloc Party and 130 patients over 90 minutes during the performance by Rage Against the Machine.

The texting sign needs further investigation to determine whether it is a valid criterion for recovery after faint or panic attack at festivals as well as in busy accident and emergency departments.

We thank the members of the pit crew and Festival Medical Services

for supporting us, and Specialized Security, which does such a great job of getting people who are in trouble out of the crowd.

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Competing interests: None declared.

1 Resuscitation Council (UK). Resuscitation guidelines 2005. www.resus.org.uk/pages/eqip/HAR.htm.

Cite this as: *BMJ* 2008;337:a2723

A symphony of maladies

Sarah Bache and Frank Edenborough
uncover scores of health problems associated with making music



Classical musicians have never been considered a daredevil bunch, and playing classical music is one of life's more genteel pastimes. Yet the perils of the seemingly innocuous activities of the orchestra have long been a closely guarded secret. Fearful of being exposed as weak and jeopardising their place in the orchestra—or worse, their livelihood—musicians often suffer in silence rather than advertise their injuries.

As two interested musicians, we carried out a Medline search of the available medical literature and scoured the internet for supportive organisations. We discovered the dangers hidden within the confines of the orchestral practice room; we also briefly looked at the dangers associated with other types of music making. Welcome to the world of fiddler's neck, laryngeal blowouts, and Satchmo's syndrome.

Musicians who tour have unique stresses placed on their health, many of which are well documented on the website of the Performing Arts Medicine Association.¹ Hours of travel disturbing the normal circadian rhythm, lack of healthy food and exercise, time spent away from home and family, and the pressures of maintaining performance excellence² and of stage fright all take their toll on physical and mental wellbeing.³

Overuse syndrome

Many hours are spent in preparation for musical performances that can last several hours. Athletes undergoing repetitive, prolonged, muscular activity are considered to be "training" and their injuries relate to the specific sports equipment used. Similarly, playing a musical instrument requires highly coordinated, repetitive fine movements under adverse conditions of unusual posture and considerable force. Thus, musicians experience similar instrument specific injuries.

Overuse syndrome is characterised by pain and tenderness in muscles and joints as a consequence of excessive use, manifesting itself as loss of agility and accuracy.⁴ Prolonged practice at the extremities of range of motion results in a plethora of disorders including tendinitis or tenosynovitis and neurological disturbance.⁵ Overuse syndrome is a valid

cause of anguish for musicians: in one study, a listening panel could distinguish between pianists' hands affected and unaffected by overuse.⁶

Instrument specific causes of overuse syndrome include strain in the right thumb of clarinettists, from loading the weight of the instrument on to the thumb rest. It may be reduced by neck straps⁷ or more ergonomic thumb rests. Supports for the right hand of flautists have also been developed.⁸ However, many overuse syndromes are not limited to a single instrument.⁹

Focal dystonias

Characterised by unwanted muscle contraction, focal dystonias are thought to be caused by overactive neural plasticity in the motor cortex, predisposed by a hereditary component and male sex.¹⁰ They are

KEY POINTS

Touring with a band or orchestra may lead to disrupted routines, late nights, poor food, reduced exercise, and stress, all of which take their toll on general health
The instrument itself, as result of its composition, weight, and shape, together with the force required to play it and the prolonged and repetitive nature of practice, may lead to a host of instrument specific injuries
Overuse syndromes, focal dystonias, dermal sensitisation, and respiratory, oropharyngeal, and cardiovascular anomalies may result
Minor injuries are amplified by the precision required to play at the highest standard and may be career threatening



Leon Fleisher spent 30 years playing only left handed concerts after excessive practice resulted in a focal dystonia

in guitar strings,²³ flute heads, and brass mouthpieces; cane reeds of saxophones and oboes²⁴; and exotic woods, rosins, and varnishes in stringed instruments.^{25 26}

The ubiquitous brown mark on the left side of the neck in players of upper string instruments (violins and violas), known as fiddler's neck, is caused by a combination of skin sensitisation, pressure, and moisture. Hyperpigmentation and lichenification produce scaling, pustules, and eventually scarring.²⁷ Flautist's chin may similarly result from friction and salivation.²⁸ Both conditions may be alleviated by beard growth, although we have yet to discover a solution for women. Similar dermatoses causing tenderness, erythema, and oedema may be seen over anatomical protuberances secondary to pressure and irritation.

Guitarist's nipple,²⁹ cellist's chest,³⁰ cello knee,³¹ and cello scrotum³² are all described, although the awkward playing position required to produce the latter makes it a rarity that has been questioned.³³

Guitarists and harpists can develop caluses, subungual haematomata, and paronychias, while Garrod's pads are thickenings over the extensor aspect of the interphalangeal joints in string players, which may mimic Heberden's or Bouchard's nodes.³⁴ Damage from playing an instrument is not restricted to damage to the musician: extreme sweating may cause discoloration of lacquered instruments and has been reported to erode instruments such as a flute and trombone.³⁵

Rupture of the orbicularis oris is known as Satchmo's syndrome

Maxillofacial and dental disorders

Musicians even have specific orthodontic problems.³⁶ Pressure under the left mandible of upper string players may be associated with dysfunction of the temporomandibular joint, producing crepitus, pain, and a predisposition to bruxism: 73% of violinists grind their teeth, compared with 34% in a control group.³⁷ Excess pressure on mouthpieces in brass players may also lead to pain from the temporomandibular joint as well as gradual repositioning of front teeth.³⁸

Satchmo's syndrome (rupture of the orbicularis oris), named after Louis "Satchelmouth" Armstrong, results in reduced range, agility, and stamina for high notes. Treatment is rest or surgical repair, leading to resumption of playing at a pre-morbid level.^{39 40}

Laryngopharyngeal disorders

Oboists, horn players, and trumpeters perform high pressure, low flow

volume Valsalva-like manoeuvres to play loudly or high in the register.⁴¹ Such high pressures can cause laryngeal incompetence, with reports of nasal speech and regurgitation of liquids, or snorting while playing.

Treatment includes speech and language therapy, lipoinjection of the soft palate,⁴² or surgical grafts or Teflon inserts to the soft palate.⁴³ Laryngocele or "laryngeal blowouts" are herniations of the laryngeal sacculle, a vestigial remnant in humans.⁴⁴ They manifest as neck swellings noticed during playing and may be associated with carcinoma of the larynx.⁴⁵

Cardiovascular disorders

Whereas sinus tachycardia related to performance anxiety comes with the territory,^{46 47} FE, as a horn player, was alarmed to discover reports of players of French horns developing

Guitarist's nipple, cellist's chest, cello knee, and cello scrotum are all described, although the awkward playing position required to produce the latter make it a rarity that has been questioned



usually painless but nevertheless can be devastating to a musician who needs to perform repetitive, accurate hand movements.¹¹ Treatments involve botulinum toxin injections,¹² sensorimotor retraining,¹³ technical exercises,¹⁴ and developing ergonomic instruments. Players of keyboards and plucked instruments are mainly affected in the right hand. Conversely, string players who use bows—who carry out more complex movements on the left—are affected on the left side.¹⁵ Woodwind instruments tend to cause bilateral problems.¹⁶ Brass players experience embouchure dystonia, causing involuntary muscle contraction around the mouth,¹⁷ tremor, and jaw closure.¹⁸

Part of the problem with treating both overuse syndrome and focal dystonias is the reluctance of musicians to interrupt practice.¹⁹ In 1985 Leon Fleisher, a professional concert pianist, told an interviewer that "there was something macho about practicing through the pain barrier." He spent 30 years playing only left handed concerts after excessive practice resulted in pianist's hand, a type of focal dystonia.²⁰

Dermatological conditions

Hours of close contact with instruments can lead to dermatitis.²¹ Irritant culprits include nickel in trumpets²²; chromium and brass

wandering atrial pacemakers during recitals⁴⁸; and carotid dissection can occur in wind players, probably because of increased intrathoracic pressure when playing.⁴⁹ Performing the Valsalva manoeuvre when playing brass or wind instruments is associated not only with changes in blood pressure and heart rate⁵⁰ but also with epidural haematomas⁵¹ and recurrent transient ischaemic attacks, secondary to patent foramen ovale, permitting microemboli to pass into the middle cerebral arteries as a result of increased right to left shunt.⁵² Circular breathing—which enables wind players to produce a continuous note by inhaling through the nose while exhaling air stored in the cheeks through the mouth—may affect autonomic control of the heart.⁵³

Respiratory problems

Musicians and the Musician's Union were some of the most ardent supporters of the recently introduced smoking ban in pubs and clubs after links were made between passive smoking and respiratory disease⁵⁴ and the deaths of several high profile musicians, including the British trumpeter Roy



Castle.⁵⁵ Wind musicians have decreased pulmonary function compared with a control group, possibly as a result of developing asthma or barotrauma when playing.^{56 57} Yet, conversely, playing wind instruments has been found to reduce symptoms in asthmatic teenagers.⁵⁸

Ophthalmic problems

High resistance wind players, such as trumpeters and oboists have been shown to have an increased intraocular pressure when playing,⁵⁹ resulting in a small but significant increase in visual field loss.⁶⁰

Deafness and tinnitus

Concern for the hearing of musicians is increasing, and members of an orchestra have been found to have more than twice the expected hearing loss for their age.⁶¹ Prevention includes earplugs, baffles, and positioning of players within the ensemble.⁶²

Conclusion

Beneath the sublimity of music lies hard work and dedication. Each instrument may exact a specific toll on any who try to

master it, and even apparently minor injuries may be devastating. We must recognise the unique requirements of this special group of patients so that they may continue to produce the music we so enjoy.

Useful resources

Bernardino Ramazzini first summarised disorders of musicians in the early 18th century in his *De Morbis Artificum Diatriba* (Diseases of Tradesmen). More recent help has become available, fortunately, from organisations that can provide musicians with contacts and advice on stress management and injury avoidance.

- Performing Arts Medicine Association (www.artsmed.org)
- Safety and Health in Arts Production and Entertainment (www.shape.bc.ca)
- British Association for Performing Arts Medicine (www.bapam.org.uk)w

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Contributors: Both authors carried out a Medline search of the available medical literature and scoured the internet for supportive organisations. FE is the guarantor.

Competing interests: FE is a member of the British Association for Performing Arts Medicine and is principal horn of the Sheffield Philharmonic Orchestra and occasional soloist. SB is an out of practice pianist.

Provenance and peer review: Not commissioned; externally peer reviewed.

Cite this as: *BMJ* 2008;337:a2646

References are in the version on bmj.com

"Only the good . . ."

A 50 year old man presented with retrosternal burning while walking up a slight incline, which resolved on resting. He had a family history of coronary artery disease and was taking drugs for hypertension and hyperlipidaemia. Five years earlier he had had angioplasty to the marginal artery and a bare metal stent had been inserted.

On this occasion physical examination was unremarkable and a resting echocardiogram was normal. However, a stress echocardiogram showed ST depression in the lateral leads that appeared at stage 3 of the Bruce protocol and continued for nine minutes in recovery, as well as reversible apical hypokinesia. Coronary angiography showed a patent stent in the marginal artery and a 95% stenosis of the left anterior descending

artery. This was successfully dilated and a bare metal stent inserted.

On more detailed questioning the patient reported experiencing increasing dyspnoea while trying to sing along to the Billy Joel song "Only the good die young" on the way home from work. He had not had any problems singing before, although observers reported that the acoustic quality of the sound was bad. Over the past three months he had been unable to sing complete phrases without needing to breathe in, whereas Billy Joel was able to sing these phrases without stopping. Driving home the day after his angioplasty, he could once again sing along with Billy Joel without dyspnoea (but the acoustic quality did not change).

A PubMed search with the keywords "singing", "dyspnea",



TERRY LOTT/SONY MUSIC ARCHIVE/GETTY IMAGES

and "coronary artery disease" did not find any articles, so we believe this may be the first report of a decrease in singing capacity as a

presenting symptom of coronary artery disease.

Further work is needed to define the sensitivity and specificity of singing capacity as a test for coronary artery disease. If it proves dependable, this opens the way for easy self assessment of heart disease, which may prevent the good dying young.

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SM was the patient in this case.

Competing interests: None declared.

Provenance and peer review: Not commissioned, not externally peer reviewed.

Cite this as: *BMJ* 2008;337:a2556